

Announcements

▣ Homework for tomorrow...

Ch. 26, Probs. 40

Ch. 28, CQ. 4, Probs. 2 & 4

CQ12: a) 2 b) $\frac{1}{4}$ c) 1

26.16: $E = 1.1 \times 10^5 \text{ N/C}$

26.18: 25 nC

26.22: $2.8 \times 10^5 \text{ N/C}$

▣ Office hours...

MW 10-11 am

TR 9-10 am

F 12-1 pm

▣ Tutorial Learning Center (TLC) hours:

MTWR 8-6 pm

F 8-11 am, 2-5 pm

Su 1-5 pm

Chapter 28

The Electric Potential (*Electric Potential Energy*)

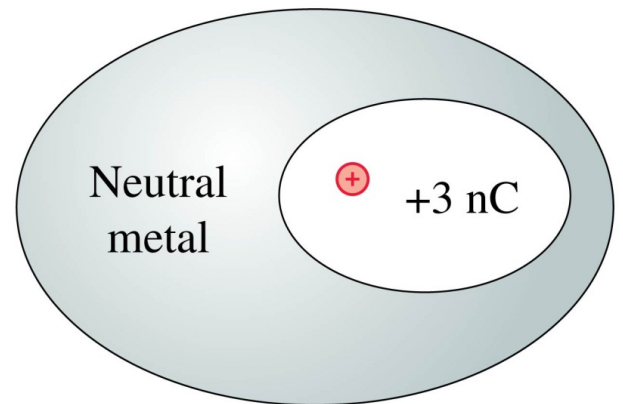
Last time...

Conductors in *electrostatic equilibrium*...

1. *E*-field is ZERO at all points w/in the conductor.
2. Any excess q resides on the *exterior surface*.
3. *E*-field at the surface of a charged conductor..
 - is *perpendicular* to the surface.
 - is of *magnitude* η/ϵ_0 , where η is the surface charge density *at that pt*.
4. *E*-field is ZERO inside any hole w/in a conductor, *unless* there is a q in the hole.

Quiz Question 1

A $+3 \text{ nC}$ charge is in a hollow cavity inside a large chunk of metal that is electrically neutral. The total charge on the exterior surface of the metal is



1. 0 nC .
2. $+3 \text{ nC}$.
3. -3 nC .
4. Can't say without knowing the shape and location of the hollow cavity.

Mechanical Energy Conservation

$$E_{mech} = K_1 + U_1 = K_2 + U_2$$

In any *isolated* system of objects interacting only through *conservative* forces, the total *mechanical energy* $E = K + U$, of the system, remains the same at all times.

or

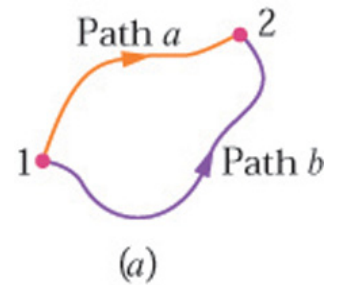
$$\Delta E_{mech} = \Delta K + \Delta U = 0$$

About *Conservative Forces*...

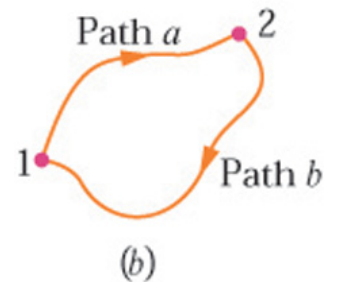
The work done by a *conservative force* on a particle

- is *path independent*.
- moving around any closed path is *zero*.

$$W_{1 \rightarrow 2}^{\text{path } a} + W_{2 \rightarrow 1}^{\text{path } b} = 0$$



- The electric force is a *conservative force*.

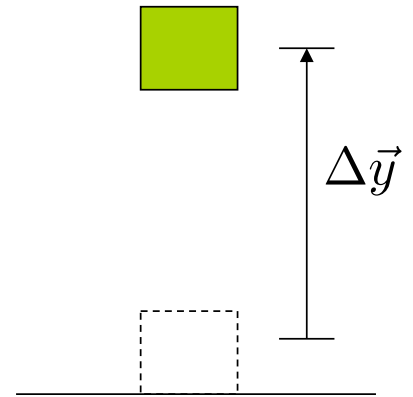


Defining Potential Energy change...

The *change in potential energy* for a conservative system is defined as the *negative* of the internal work the system does on itself when it undergoes a reconfiguration.

$$\Delta U \equiv -W$$

□ Potential energy is *stored work*!



Potential Energy cont..

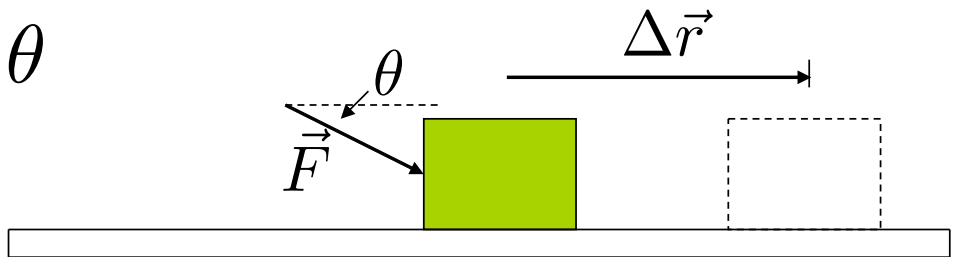
Notice:

- ▣ Potential energy is *stored* energy waiting to be 'let loose'.
- ▣ Potential energy is a relative energy...
The zero-reference level is arbitrary & must be chosen.
- ▣ Can only measure a *change* in P.E.

Work done by a *Constant Force*...

The *work* done by a *constant force* on a particle?

$$W = F \Delta r \cos \theta$$



in terms of the *dot product*

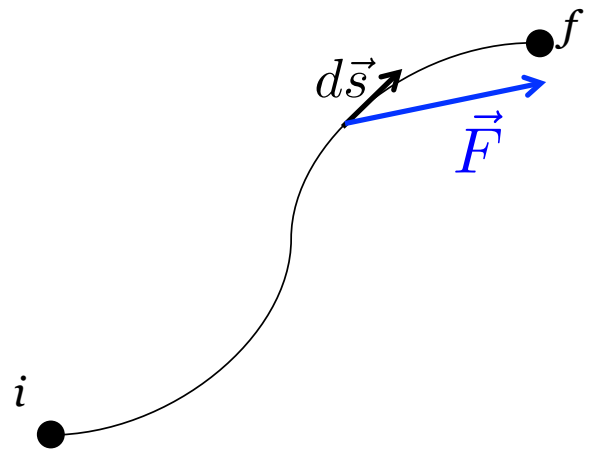
$$W = \vec{F} \cdot \Delta \vec{r}$$

□ But what about a *variable force*?

Work done by a *Variable Force*...

The *work* done by a *variable force* (or a *variable path*) on a particle?

$$W = \int_i^f \vec{F} \cdot d\vec{s}$$



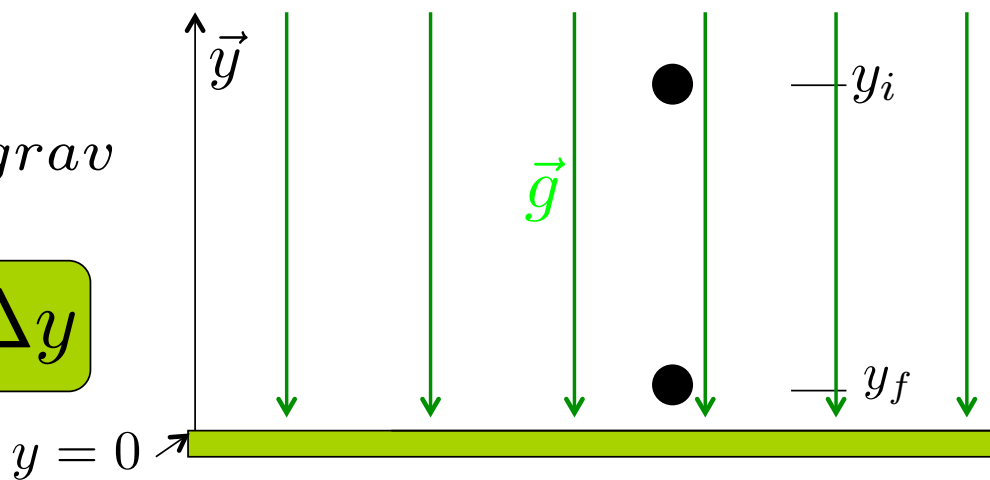
For a *uniform* g -field...

The *work done* on a particle of mass m falling in a g -field is...

$$W_{grav} = \vec{F} \cdot \Delta \vec{r}$$

$$W_{grav} = -\Delta U_{grav}$$

$$\Delta U_{grav} = mg\Delta y$$



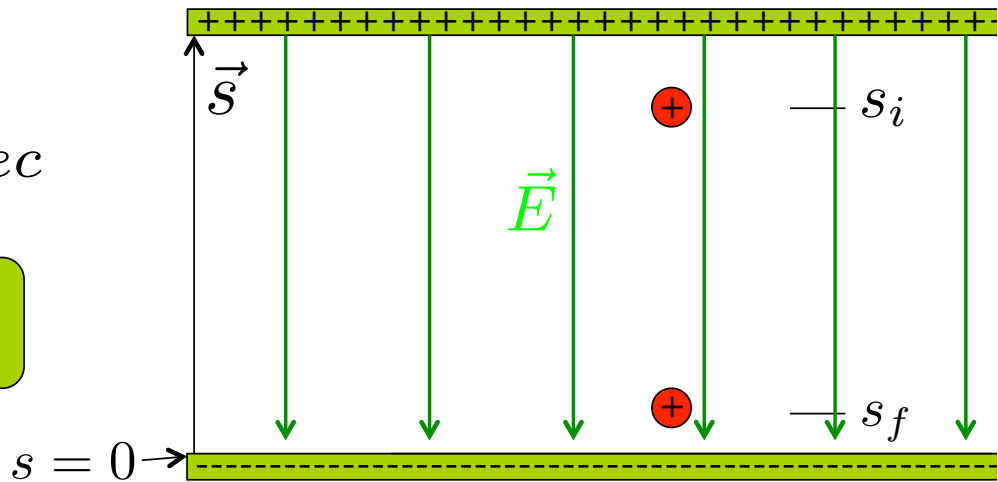
For a *uniform* E -field...

The *work done* on a particle of charge q ‘falling’ in an E -field is...

$$W_{elec} = \vec{F} \cdot \Delta \vec{r}$$

$$W_{elec} = -\Delta U_{elec}$$

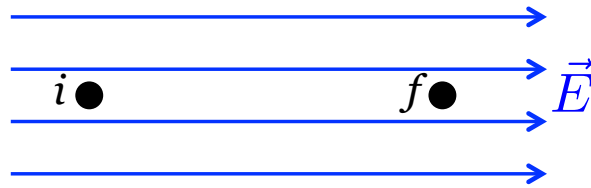
$$\Delta U_{elec} = qE\Delta s$$



□ But what about a *negative* charge?

Quiz Question 2

An e^- moves from point i to point f , in the direction of a uniform E -field. During this displacement...



1. The work done by the field is *positive* and the potential energy of the electron-field system *increases*.
2. The work done by the field is *negative* and the potential energy of the electron-field system *increases*.
3. The work done by the field is *positive* and the potential energy of the electron-field system *decreases*.
4. The work done by the field is *negative* and the potential energy of the electron-field system *decreases*.
5. The work done by the field is *positive* and the potential energy of the electron-field system *does not change*.

i.e. 28.1:

Conservation of Energy

A 2.0 cm x 2.0 cm parallel-plate capacitor with a 2.0 mm spacing is charged to ± 1.0 nC. 1st a proton, then an electron are released from rest at the midpoint of the capacitor.

- a. What is each particle's change in electric potential energy from its release until it collides with one of the plates?
- b. What is each particle's speed as it reaches the plate?